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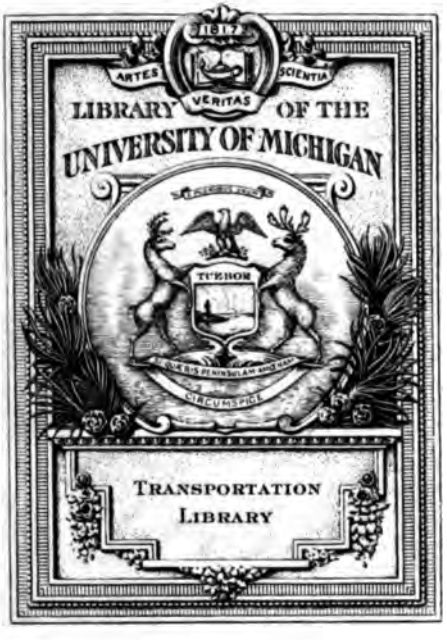
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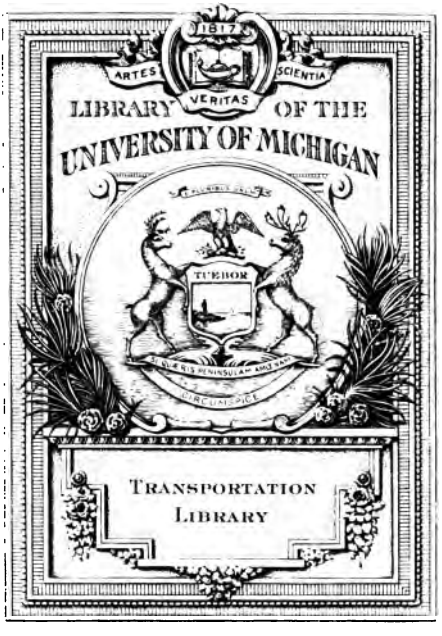
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REMARKS

ON

STEAM NAVIGATION,

AND ITS

PROTECTION, REGULATION, AND ENCOURAGEMENT.

IN

A LETTER

TO THE

RIGHT HONOURABLE WILLIAM HUSKISSON,

TREASURER OF THE NAVY, AND PRESIDENT OF THE

BOARD OF TRADE.

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By THOMAS TREDGOLD, Civil Engineer,

MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS, &c.

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1825.

REMARKS

ON

STEAM NAVIGATION,

&c.

SIR,

A VESSEL has lately been fitted up to go to Calcutta, which is to be impelled by steam-power, and having been in it during a short excursion to try the power of the engines, I was naturally led to reflect on the probable benefits of this mode of propelling vessels.

The subject has often engaged my attention, and its progressive improvement I had watched with no common interest; for surely no other art ever advanced with such gigantic strides in the public service.

But now it assumes a new feature; for it holds out the prospect of enabling travellers to make

a continuous and rapid progress, even to the most distant parts of the globe; and almost with unerring certainty: a prospect which appeared distant, rather from the boldness and risk of a first trial, than from any fear of its being ultimately realized.

I expected a more gradual extension of the voyages of steam-vessels; and if not great improvements in them, at least systematical construction, combining the advantages which time generally adds to the perfection of a complex machine.

But this cool method of reasoning on a subject, so interesting to a commercial nation, is not consistent with the speculative nature of the times; and still less so with the spirit of enterprise which animates almost all classes of my countrymen.

The advantages of steam-navigation have now become so evident that it will soon be applied in every case where, on trial, it is found to afford a competent return to the capitalist; and in proportion as it is extended it must add to the commercial intercourse and general welfare of the British empire.

A system of communication and traffic which promises so much will unquestionably receive every attention which is due to its importance from every branch of His Majesty's Government; and, indeed, by one department, the Post-office, it has not only been encouraged but applied, and most successfully, to facilitate the communication between this country and Ireland; consequently, having experienced its advantages, they can have no doubt that they are dispensing a real benefit in affording it their warmest support.

There is, however, another and a most important duty for the Government to attend to in consulting the interests of steam-navigation, and to which it is the principal object of this letter to direct your notice. Steam-power has been chiefly used for passage-vessels, and it is to provide for the security of the lives and property of the passengers that certain regulations have now become necessary; and I trust I shall be able to show that an attention to such regulations would most effectually tend to improve the certainty and safety of steam-navigation.

You will readily concede that every precaution which human intelligence can devise ought to be taken to ensure the safety of a vessel setting out to sea with from one to two hundred people on

board; and that the serious duty of examination ought to be confided to an able and respectable engineer.

Now individuals among the passengers cannot be expected to procure such examination, and want of knowledge must in ninety-nine cases out of a hundred prevent them doing it themselves. It is alike improper, that either the proprietors, their manufacturers, or their assistants, should be altogether depended on in such a case; — and the proprietors, who have right feelings of the duty they owe to themselves and to the public, would be grateful for some means of knowing whether their engines and machinery were in a right condition for the service they intend them or not; and particularly in the case of new machines and engines.

For the machinery of a steam-vessel may be too slight for its power, or constructed of improper materials; or it may be in imperfect repair. Conceive a vessel to set out to sea with all or any of those defects, and to meet with rough weather, the consequences are obvious, and distressing to reflect on.

The impulse of the swell of the sea often brings the machine to rest, and the next moment

the wheels are left at liberty in the hollow between the waves, and acquire a new momentum to meet the shock of the next billow. In this state the strength of the machinery is tried to the utmost; and failure from deficient strength leaves the vessel completely at the mercy of the elements.

While a steam-vessel is perfect its course is not dependant on the winds and waves; and the disposition of its weight, when it is properly disposed, gives it great stability; hence, it is safer than an ordinary sailing vessel in a storm; but as one of these advantages depends on the proper disposition of the weight, and the other on the parts of the engine being of abundant strength, who will not be struck with the hazard of the parts being made too slight to save an expensive material, and of the whole being conducted by presuming ignorance?

The manufacturers of high reputation, who have hitherto supplied nearly all the steam-boats with engines and machinery, cannot continue to supply the demand; and, therefore, part of them must be supplied from less experienced manufacturers, and be formed by less skilful workmen. They must be obtained from the trading manufacturers, who seek more for profit than

for reputation; and the proprietors of steamboats will require protection as well as their passengers.

It must be obvious from the nature of the strains arising from the shocks of the waves, that a tough and elastic material is best adapted for most of the parts of the machinery; and, therefore, malleable iron, which is tough and ductile when its range of elasticity is exceeded, is far superior to cast iron, which is brittle and not so strong. And since malleable iron is not only more expensive but also more difficult to reduce to the proper forms than cast iron, it will too frequently be rejected when it ought to be used.

Again, the state of repair, the state of the safety-valves, the care to avoid a risk of fire by construction, and the provision of fire-engines, and boats in case of accidents, each requires to be examined instead of being left to the discretion of the proprietors. For we well know that men seldom provide against contingent evils unless compelled by authority; and will then esteem the compliance with the conditions a hardship, even while the benefit resulting from the enforcement of these conditions is clear and evident, and daily experienced.

I allude more particularly here to the provisions of the building act, which requires that the division or party walls between the dwelling-houses in London shall be of a certain thickness, with a view to render them fire-proof. And, where these provisions are complied with, a fire rarely extends beyond the house where it commenced. This salutary regulation is well known to be no check upon the progress of proper buildings, though among builders of a certain description every artifice is employed to evade a compliance with its provisions. It is not without reason, therefore, that an equal neglect in the construction and management of steam-vessels may be expected to take place if a timely interference does not prevent it.

I might here enumerate various cases where the legislature has interposed to prevent one or more individuals putting the lives and property of their fellow-citizens in hazard for their own pecuniary gain; but I think the propriety, and even duty, to make such interposition is a thing sufficiently manifest in itself, and does not need a reference to cases and precedents. Otherwise the appointment of district-surveyors for buildings, and dangerous manufactures, and of superintendents for gas-works to guard against explosions, might be quoted; and in navigation

part must be competent to resist the stress upon it, with a proper allowance for contingencies; and neither the invention of new combinations nor a change of the nature of the first mover will be limited by forming a settled law for the proportion of strength to resist a given power. Even the use of high-pressure steam should not be prevented, because that would very probably interfere with improvements in the application of steam. Therefore, neither invention nor ingenuity can be cramped by the projectors satisfying the protectors of the lives and property of the people that real skill and science has been manifested in the construction and guards against accidents in a new machine for such an important object. But I will proceed to develope my plan, and then you will be better able to judge how far it will interfere with invention, discovery, or the application of new principles.

The plan I propose for guarding against any serious accident, as much as possible, is to establish an authorised inspector, of known respectability and reputation in his profession, at each station or port from whence steam-vessels go, and to furnish him with a code of instructions to guide him in the performance of his duty; of which instructions copies should be accessible, at a moderate charge, to the public. And it

should be enacted, and be a law, that each master of a steam-vessel should, previous to the departure of his vessel, give notice to the inspector, and allow him full liberty to inspect the vessel and its engines.* Also that the inspector should furnish the master of the vessel with a certificate of such inspection bearing his signature, and the date of inspection, to be placed in a conspicuous part of the vessel, for the perusal and satisfaction of the passengers. This certificate to be granted only on condition of the vessel being in a fit state for her voyage in regard to strength, protection from danger of fire, good condition of boilers and machinery, and proper provision for escape in case of danger; all of which are to be judged of by the rules given in the code of instructions. †

* But for short passages inspection for each time would not be necessary, and therefore such vessels should be examined not oftener than once in a month, nor seldomer than once in six weeks.

† The Committee of the House of Commons say, in their Report, that "they are decidedly of opinion that the owners of steam-vessels who omit to provide a sufficient number of boats, to secure the safety of their passengers, in case of any sudden accident, are guilty of great neglect." — "Besides this precaution, in respect to boats, there ought to be on board every steam-boat, for the perusal of the passengers, a certificate of some experienced engineer, to testify the strength of the boilers, the sufficiency of the valves, the

And that this duty may be performed in a proper manner, and without prejudice, I further propose, that a regular report of the state of all vessels examined should be forwarded to the office of a principal superintendent or director in the metropolis, as a check upon the conduct of the reporting inspectors.

The principal difficulty would arise in forming a code of instructions; but whatever this difficulty may be, it will be an invaluable document, if formed in a proper manner. For that body of instructions which will enable an inspector to judge of the fitness of a machine, whether of new or old invention, must also be a most perfect guide for the manufacturer; and I presume that no one will venture to assert that any single manufacturer could form an equiva-

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safety of the furnaces, and the general good condition of the vessel and machinery." And in respect of the Holyhead packets, they hold the following language: "Your Committee particularly recommend, as indispensably necessary for economy as well as safety, according to the opinions of all the witnesses who were examined to this point, that a professional engineer should be employed to reside constantly at Holyhead, to superintend the machinery and inspect the engine-keepers. And also that each vessel should be supplied with an extinguishing fire-engine, and with two large boats in addition to the ordinary ship's boat."

lent one to guide his conduct in the manufacture of engines. Hence, the labours of a committee appointed to manage this important department would be a means of perfecting a most desirable improvement in the application of steam or other engines, even were they to furnish only a code of instructions; as they would have it in their power to make most of the scientific and practical knowledge in the country instrumental in effecting this object.

It is scarcely possible for any one, not an engineer, to form an adequate idea of the good that would result from a settled scale of proportions for engines according to their different powers. It would equally guard against the mistakes of those who calculate and the uncertainties of those who guess the bulk that is competent to resist the strains in a steam-vessel. It must render the estimation of expence less difficult, and more certain; and relieve the proprietors of steam-vessels from the trouble of comparing and judging respecting the competency of a specified plan, or of a new engine for a vessel.

That there is knowledge existing in this country sufficient to give a high degree of perfection to a code of instructions for the manu-

facture of engines for steam-vessels will not be doubted; but the means of bringing this knowledge to bear on the subject is not quite so obvious. If a set of queries were proposed to men conversant only with the pure sciences, the answers would no doubt be as discordant as those were respecting a project for an arch of 600 feet span, which was once designed for a bridge across the Thames. On the contrary, if you place before a man of science a fair and clear system of reasoning by which certain proportions and rules have been obtained, and then inquire whether they have been truly and accurately investigated or not, and whether to the best of his judgment any questionable principle has been reasoned upon, then a definite and rational answer would be given. But a professor who has reasoned all his life on the supposition that mechanical bodies are perfectly hard, perfectly smooth, and perfectly inflexible, is not aware of the difference which results from softness, friction, flexibility, temperature, and various other causes well known to practical men; and therefore it is too much to expect from him a knowledge of all the circumstances which interfere with the pure mathematical theory of magnitude and velocity, unless they be detailed before him.

Again, from mere practical men facts alone ought to be received, and facts divested of the obscurity of technical language, and in no case inferences, unless the facts on which they are formed be fully detailed; but after the rough draft has been completed, it would be an excellent plan to place copies in the hands of several practical men, and let each of them state where they observed a defect, and prove it so by a reference to facts. A sweeping censure, the resource of presuming but positive ignorance, must not be allowed; for he who cannot reason of particulars is unfit to judge of the whole.

I have all along supposed that a first investigation had been acquired, and there would be no difficulty in obtaining such a one; for, fortunately, there are a few men who have studied the true theory of machines, and unite scientific with practical knowledge.

Having considered the steps which might be taken with much advantage in the management of this important subject, and endeavoured to point out a mode of protection and encouragement, which would leave the progress of steam-navigation perfectly at liberty, and yet secure the community from improper speculation, I

As a means of towing vessels in and out of harbours, steam-vessels have already been applied with great success; and I am somewhat surprised that the same means is not more extensively used to facilitate the navigation of rivers. On the Tyne it is adopted, and its use increases, but it might be still more successfully applied on the Thames; and it is not improbable that it will be found of use for towing vessels at sea, in cases where navigation is difficult, tedious, and interrupted by currents.

But instead of towing sailing vessels, the direct application of steam-power to propel vessels of burden will soon be resorted to for short voyages, where the trade is considerable, and the navigation difficult. This important branch of steam-navigation has yet to be commenced, and will very likely be shortly put on trial.

The advantage of steam-power in the Irish and Welsh trade would be immense, while the additional capital necessary to conduct the trade would be increased only in a small proportion. For by the application of steam-power the danger, delay, and difficulty of the navigation round the Land's End would be rendered trifling.

The hazards arise chiefly out of the detention of vessels by the prevalence of particular winds, and in such a case, the value of steam-power is incalculably great: it renders beating about in expectation of more favourable winds unnecessary, and calms cease to be a cause of delay; it also renders the risk of deviation from the course of the vessel in currents much less; and such deviation is often the source of the most distressing accidents which happen at sea.

When voyages are long, the quantity of fuel required leaves very little spare tonnage for goods, hence, there is a limit to this application of steam. It will also be obvious, that the advantages of steam for heavy vessels must be confined to ports where fuel is cheap and plentiful.

The first efficient steam-vessel in Britain was started on the Clyde only in 1811; and the rapid advances which has since been making every season, in adding new vessels, in sailing to greater distances, and through heavier seas, at once indicates the value of this application of steam-power, and the necessity of guarding against its abuse. In 1823, there were upwards of one hundred and sixty British-built steam-vessels,

and 22 of these were of 200 tons' burden, or upwards.*

These simple facts speak volumes on the subject: the progress of steam-navigation is truly grand and imposing: it is completely without a parallel in the history of art: it has facilitated

* A List of the Steam-vessels built in Britain from 1811 to the End of 1822.

Year.	No. of Vessels built.	Aggregate Tonnage of Vessels.	Aggregate Horses' Power of Engines.
1812	2	65	13
1813	7	361	71
1814	8	441	95
1815	5	317	85
1816	9	802	214
1817	9	620	142
1818	12	1630	386
1819	13	1280	393
1820	16	1558	500
1821	38	5615	1606
1822	23	3419	1217

It is worthy of notice, that the average proportion of the horse-power to the tonnage of the vessels commences with 1 to 5, and increases irregularly to 1 to 4 in 1816, and for 1822 it approaches very nearly to 1 to 3; that is, 3 tons for each horse-power. In 1821 the greatest number of vessels were built, the number being 38, and their tonnage 5615 tons.

See Report of a Committee of the House of Commons on Steam-boats, being the fifth Report on the Roads from London to Holyhead, &c.

the communication between the different states of Europe; and, by increasing the friendly and commercial intercourse of men in all countries, it is to be hoped that it will soften prejudices, and remove sources of animosity, and contribute to ameliorate the condition of mankind, by disseminating a general spirit of industry, and a desire for that true knowledge which Lord Bacon so emphatically calls power.

I might now proceed to examine the present state of the science of steam-navigation, and show the objects which require the attention of those who wish to improve the construction of vessels for that purpose, and of the engines and machinery; but this would involve me in a tedious investigation, in which I could only expect to be followed by those engaged in these works.

It will be sufficient to remark respecting the form of the vessel, that some means should be adopted for determining the best form for moving through the water; for the forces acting to impel a steam-vessel being in a direction differing very considerably from those acting on a sailing vessel, the same vessel would have different water-lines when in motion, according to the direction of the power impelling it, and, conse-

quently, different resistances, unless it were of a form differing from that of any known vessel. The opinions that a steam-boat should resemble this or that species of sailing vessel are entirely conjectural, and only serve to inform us how ignorant we are of nautical science, when conjecture is substituted for scientific deduction from first principles.

The construction of the vessels is another important part; but to those who comprehend the nature of framing carpenter's work it is exceedingly simple: the most obvious condition is a firm longitudinal connection of the upper works; and in procuring this connection iron-work should be chiefly depended on, on account of the difficulty of connecting timber to resist longitudinal strains: the lower works should be chiefly designed to resist compression, and to resist it without having a tendency to bulge or change the form of the vessel. The two parts should be as much connected and stayed by triangular framing as estimation shows to be sufficient to give a surplus of strength far beyond any extraneous force that could possibly act on the vessel.

Reflecting how easy it is to determine, in an approximate manner the magnitude and direction of every strain it is possible a vessel could be

exposed to, and that nothing of this kind appears to be done in works on naval architecture, it may have its use to remark, that an expert teacher would equally as soon teach a student how to determine every principal line of strain, and the quantity of matter sufficient to resist it, for any species of vessel, as he could teach him the eight books of Euclid which are usually taught in schools; and which of these courses would tend most to improve the student's reasoning faculties, as a naval architect, *I* neednot be at the trouble of explaining.

In regard to engines and machinery, various improvements may be made, and it is probable that in process of time they may approximate to doing the same work with about two-thirds of the fuel, or perhaps it may be reduced to one-half the present consumption; and not by the introduction of new inventions, but by mere attention to the proportions and arrangement of those already known.

In regard to the mode of acting on the water for propelling the vessel, means of making the paddles accommodate themselves to the surface of the water, under every variation of the position of the vessel, is one of the desiderata; but I do not expect that any thing more effective

paddles will be substituted for them, because there are so few modes of acting on the water so as to be efficient in impelling forward a large vessel that will admit of being made of the necessary magnitude required in practice.

By the united effect of sails and steam-power I expect much will be done in passage-vessels for long voyages. But success will in a great measure depend on a close study of the seasons and of the seas that are to be navigated. I see, with pleasure, that a more direct communication with our American colonies and the United States is contemplated through the agency of steam-power by a company which has already obtained the sanction of parliament. They propose that from the port of Valentia, in the south-west of Ireland, a steam-vessel of a large class, with machinery and fuel adequate to cross the ocean, shall proceed to Halifax in Nova Scotia, and to New York, once a fortnight; and another of similar power proceed every month by Madeira and the leeward islands to Jamaica, returning by Bermuda and Fayal.

Various other lines of communication are proposed to be established by the same company, and similar companies are forming for other great, though perhaps less important, objects.

On the whole, steam-navigation is a subject which demands attention, and particularly in a country like this, where human ingenuity is constantly on the stretch to maintain our rank as the leaders in practical science and art among the nations around us.

If I have been successful in showing that steam-navigation may be both improved and rendered more safe by the attention of the legislature, my object is attained; and having closed for the present those arguments which I thought it my duty to offer to your notice,

I have the honour to be,

Sir,

Your most obedient Servant,

THOMAS TREDGOLD.

Grove Place, Lisson Grove,
August 10. 1825.

APPENDIX.

ON ARRANGING THE SPEED OF STEAM-VESSELS.

WHEN a steam-vessel has to convey goods to a considerable distance, the deduction from its tonnage for the fuel for the voyage becomes considerable. If there had been a rate which would have given a maximum quantity of free tonnage it would have been very desirable to have ascertained it, but the following inquiry will show that no such velocity can be given.

Let t be the tonnage which an engine that consumes f tons of coal per hour will impel at the velocity V miles per hour; and let d be the distance of the passage in miles; and v the velocity in miles per hour, at which the steam-vessel is to travel.

Then, the tonnage being inversely as the cube of the velocity when the power of the engine is the same, we have $\frac{1}{V^3} : \frac{1}{v^3} :: t : \frac{tV^3}{v^3}$ = the tonnage the engine would impel at the velocity v.